

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
30 June 2005 (30.06.2005)

PCT

(10) International Publication Number
WO 2005/059317 A1

(51) International Patent Classification⁷: F01D 17/14, F02B 37/007, 37/18, F02C 6/12

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(21) International Application Number: PCT/EP2003/014013

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(22) International Filing Date: 10 December 2003 (10.12.2003)

(84) Designated States (regional): ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(25) Filing Language: English

(26) Publication Language: English

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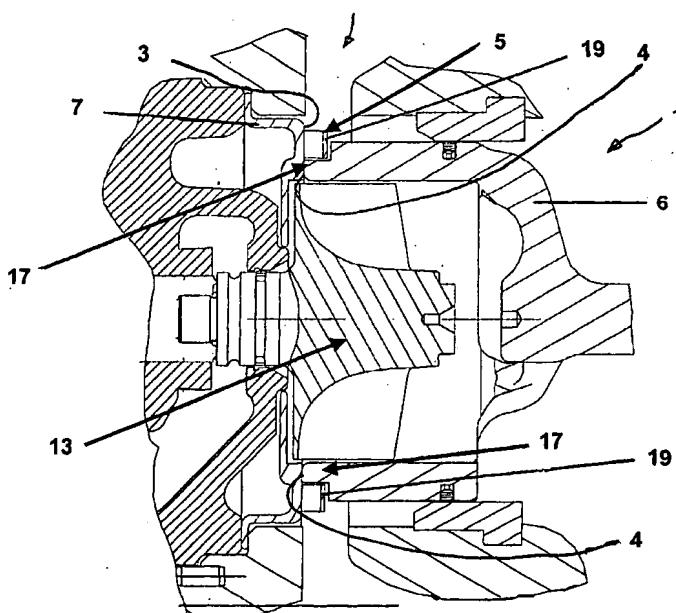
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Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: VARIABLE NOZZLE DEVICE FOR A TURBOCHARGER



WO 2005/059317 A1

(57) Abstract: A nozzle device for a turbine of a turbocharger according to the present invention comprises variable annular nozzle (2) defined between an inboard wall (3) and an outboard wall (4), wherein said outboard wall (4) is axially movable for completely closing said variable annular nozzle (2).

VARIABLE NOZZLE DEVICE FOR A TURBOCHARGER

Description

The present invention relates to a variable nozzle device and in particular to a variable nozzle device for a turbocharger. Also, the invention relates to a parallel configuration of turbochargers and a method for operating the same, a diesel engine boosting system and an engine boosting system.

The International Patent Application PCT/IB03/00042 discloses a parallel configuration of turbochargers (101, 102), both turbines (T, T) thereof are connected in parallel according to Fig. 11. At low rotational speeds, the second turbocharger is not operated. This configuration needs an external control valve (100) for fully closing the turbine of the second turbocharger at low rotational speeds. At high rotational speeds, the valve must be opened to operate the second turbocharger.

A fully closable nozzle device is known from the Japanese Patent Publication JP-A-2002-038964. The variable nozzle device is constituted by pivotable vanes such that a geometric arrangement of the flow passage is adjustable. The tips of the pivotable vanes respectively abut against an adjacent vane such that the flow passage through the nozzle is nearly fully closed.

It is the object of the present invention to provide means for fully closing the flow passage to the turbine for a turbocharger having a simplified and reliable structure.

The object is solved by a nozzle device for a turbine of a turbocharger, comprising a variable annular nozzle defined between an inboard wall and an outboard wall, wherein said outboard wall is axially movable for completely closing

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said variable annular nozzle. Advantageously, the inventive nozzle device needs no external control valve for closing the turbine.

Preferably, an annular arrangement of vanes is interposed in said variable annular nozzle, and said outboard wall is constituted by a tube-shaped piston which is axially slid able into the radial inside or onto the radial outside of said annular arrangement of vanes so as to contact said inboard wall. The vanes and the tube-shaped piston regulate the exhaust gas flow into the annular nozzle.

The tube-shaped piston may comprise a stepped portion which is axially slid able onto the radial outside of said annular arrangement of vanes, wherein the stepped portion directs exhaust gas entering into the turbine to the downstream side of the turbine. This is advantageously when the exhaust gas flow shall bypass the turbine wheel, for instance when a catalyst shall quickly be heated up.

Preferably, the annular arrangement of vanes extends only over a part of the maximum interval between said inboard and outboard walls so that there is no flow resistance due to the vanes when the annular nozzle is fully opened, i.e. when the interval between the inboard and outboard walls becomes maximum.

The inboard wall may be constituted by a vaned shroud having said annular arrangement of vanes.

The object is also solved by a engine boosting system comprising a parallel configuration of a first and a second turbocharger, wherein a turbine of said second turbocharger comprises a variable nozzle device which is capable of completely closing the nozzle opening thereof.

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Advantageously, the engine boosting system needs no external control valve for closing the turbine.

The object is also solved by a method for operating an internal combustion engine with a parallel configuration of turbochargers, wherein the variable nozzle device of the second turbocharger (8) completely closes its nozzle opening when said second turbocharger (8) is driven under low rotational speed of the engine.

The present invention may be used in a diesel engine boosting system comprising a turbocharger comprising a compressor and a turbine having the nozzle device according to the present invention and control means for closing the turbine annular nozzle to an optimum position for engine braking where there is provided a high boost pressure and a high back pressure at the same time. A diesel engine generally requires for an engine braking operation, on the one side, a high back pressure upstream of the turbine to achieve a high engine brake effect. The back pressure upstream of the turbine increases as the opening of the nozzle device decreases. On the other side, the pressure within a combustion cylinder of the engine must be on a high level for maintaining the high back pressure upstream of the turbine. That is, for achieving a high pressure in the cylinder, the boost pressure downstream the compressor must be high which in turn requires an operation of the compressor to some extent. The compressor increases the boost pressure as the opening of the nozzle device in the turbine increases. Consequently, the opening of the nozzle device must be optimised so as to achieve a large back pressure upstream the turbine as well as a large boost pressure downstream the compressor. The optimisation of the nozzle opening is preferable performed by an electronically control device, for instance by means of a feedback-control

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of the back pressure upstream the turbine. The back pressure may be detected by means of a pressure detecting device which is disposed upstream the turbine. The electronically control device variably feedback-controls the nozzle opening and must be free of any mechanical restrictions thereof. Thus, the variable nozzle device according to the present invention is advantageously suitable for this diesel engine boosting system because it is completely closeable so that there are no mechanical restrictions during the optimisation process.

The present invention may be used in an engine boosting system comprising a turbocharger and a catalyst disposed downstream of said turbocharger, wherein the turbocharger comprises an exhaust gas driven turbine having a turbine wheel and an annular nozzle which can be opened such that the exhaust gas flow substantially bypasses the turbine wheel. The catalyst exhibits its optimum purifying function only when the catalyst has reached a specific exhaust gas purifying temperature. Thus, at the start of the engine, the catalyst must be heated up immediately. For doing so, the nozzle device of the turbine, which is normally fully closed at low rotational speeds, is opened even at low rotational speeds at the start of the engine such that the exhaust gas flow substantially bypasses the turbine wheel of said turbine. The full open position of the nozzle device prevents heat loses at the turbine for heating up the catalyst very quickly.

Preferred embodiments of the invention are explained by way of examples with reference to the accompanying drawings.

Fig. 1 shows a lateral section of a turbine having a nozzle device according to a first embodiment of the present invention.

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Fig. 2 shows a lateral section of a turbine having a nozzle device according to the first embodiment of the present invention.

Fig. 3 shows a lateral section of a turbine having a nozzle device according to the first embodiment of the present invention.

Fig. 4 shows a lateral section of a turbine having a nozzle device according to the first embodiment of the present invention.

Fig. 5 shows a vaned shroud of the nozzle device according to the first embodiment of the present invention.

Figs. 6A and 6B show an assembly of the vaned shroud and a tube-shaped piston of the nozzle device according to the first embodiment of the present invention.

Fig. 7 shows schematically a parallel configuration of turbochargers, wherein one of the turbochargers comprises a nozzle device according to the first embodiment of the present invention.

Fig. 8 shows an application of the turbocharger having a nozzle device according to the present invention in a diesel engine boosting system.

Fig. 9 shows an application of the turbocharger having a nozzle device according to the present invention in an engine boosting system.

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Fig. 10 shows another application of the turbocharger having a nozzle device according to the present invention in an engine boosting system.

Fig. 11 shows schematically parallel configuration of turbochargers according to the prior art.

A first embodiment of the present invention is explained with reference to the Figs. 1 to 4.

Turbocharger

The nozzle device according to the invention is part of a turbocharger 8. The turbocharger 8 basically comprises an exhaust gas driven turbine 1 and an inlet air compressor (not shown). The inlet air compressor is driven by power generated by the exhaust gas driven turbine 1, wherein a turbine wheel 13 of the exhaust gas driven turbine 1 is mounted on a common shaft with a compressor impeller (not shown) of the inlet air compressor.

Turbine

The turbine 1 is provided with a housing (not shown) having an exhaust gas inlet (not shown) and an annular nozzle 2 for guiding the exhaust gas from the exhaust gas inlet to a turbine wheel 13 of the exhaust gas turbine 1.

Annular Nozzle

In Figs. 1 to 4, the variable annular nozzle 2 is defined between an inboard wall 3 and an outboard wall 4, wherein said outboard wall 4 is axially movable for opening and completely closing said variable annular nozzle 2. An opening degree of the annular nozzle 2 is defined by the variable distance between the inboard and the outboard wall 4. The exhaust gas flow guided through the annular nozzle 2

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rotates the turbine wheel 13 in accordance to the opening degree of the annular nozzle 2.

Inboard wall

The inboard wall 3 of the nozzle device according to the first embodiment is constituted by a vaned shroud 7 having an annular arrangement of fixed vanes 5 thereon. Thus, the fixed vanes 5 are interposed in said variable annular nozzle 2 to force the flow of the exhaust gas into a predetermined direction, as it is shown in Figs. 2 to 4.

Fig. 5 shows the vaned shroud 7 having the fixed vanes 5 in more detail. The shroud 7 comprises a fixed vane support plate 3 serving as the inboard wall 3. The fixed vane support plate 3 is substantially circular in shape and is provided with an opening in a center portion thereof. The fixed vanes 5 are arranged on one surface of the fixed vane support plate 3 so as to protrude therefrom. The vanes 5 are substantially fan-shaped and slightly oblique with respect to the tangent of the fixed vane support plate 3. The design of the vanes 5 is optimised to get maximum efficiency of the turbine 1 at a transition phase which is shown in Fig. 2. On the opposite side of the fixed vane support plate 3, the tips of the fixed vanes 5 are connected with a fixed vane tip ring 19. The fixed vane tip ring 19 increases the rigidity of the fixed vanes 5, and furthermore, the fixed vane tip ring 19 contributes to direct the exhaust gas flow 18 to the turbine wheel 13, as it can be gathered from Figs. 2 to 4.

Outboard wall

With reference back to Figs. 1 to 4, the outboard wall 4 of the nozzle device according to the first embodiment is constituted by a tube-shaped piston 6 which is axially slid able into the radial inside of said annular arrangement

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of vanes 5 so as to contact said inboard wall 3. Alternatively, the tube-shaped piston may be axially slidable onto the radial outside of said annular arrangement of vanes 5. According to Figs. 6A and 6B, the tube-shaped piston 6 is provided so as to substantially surround the exhaust gas turbine wheel 13. The tube-shaped piston 6 forms downstream thereof an exhaust gas outlet 20 of the turbocharger apparatus. The tube-shaped piston 6 is preferably driven by a pneumatic actuator (not shown) connected to a driving rod 21 of the tube-shaped piston 6.

In Figs. 1 to 4, the tube-shaped piston 6 according to the first embodiment comprises a stepped portion 17 at its distal end, which is axially slidable into the radial inside of the fixed vanes 5. The stepped portion 17 comprises a small outer diameter portion at the distal end of the tube-shaped piston 6 and a large outer diameter portion adjacent thereto. The stepped portion 17 according to the first embodiment enables to accurately fit the end of the tube-shaped piston 6 between the turbine wheel 13 and the fixed vanes 5, as it is shown in Fig. 1.

In Figs. 6A and 6B, the vaned shroud 7 is assembled with the tube-shaped piston 6. Fig. 6A shows the half-opened nozzle 2 in accordance to Fig. 2, while Fig. 6B shows the fully opened nozzle 2 in accordance to Fig. 4. From Fig. 6B it is obvious that the annular arrangement of vanes 5 extends only over a part of the maximum interval between said inboard and outboard walls 3, 4, i.e. the maximum interval between the shroud 7 and the tube-shaped piston 6 when the nozzle 2 is fully opened. This is because the vanes 5 are optimised to get maximum efficiency of the turbine 1 in particular at the transition phase which is shown in Fig. 2. When the annular nozzle 2 is fully opened,

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primarily a maximum exhaust gas flow is required which must not be restricted by any vanes.

Fig. 7 shows a parallel configuration of turbochargers, comprising a first turbocharger 9 having a first turbine 23 and a first compressor 24, and a second turbocharger 8 having a second turbine 1 and a second compressor 25, wherein the first and second turbines 23, 1 as well as the first and second compressors 24, 25 of both turbochargers 9, 8 are connected generally parallel in relation to an internal combustion engine, respectively (not shown).

According to the configuration, fresh air is fed in parallel to each of the compressors 24, 25 by means of a first fresh air conduit 26 and second fresh air conduit 27, and the air discharged from the compressors 24, 25 is guided through an intercooler (not shown) to the intake side of the internal combustion engine (not shown). In the parallel configuration of turbochargers, the second compressor 25 is provided with an air re-circulation valve 28 using air flow regulating means for adjusting the amount of the re-circulated air. The re-circulation system in this embodiment includes a bypass conduit 29 with a butterfly valve 28 for adjusting the air mass-flow re-circulated back into the second fresh air conduit 27. At the exit of the second compressor 25, an additional butterfly valve 30 is provided for adjusting the flow of fresh air being discharged from the second compressor 25 into the engine.

At the turbine side of the configuration, the exhaust from the engine is fed through a first exhaust conduit 31 and a second exhaust conduit 32 to the first and second turbines 23, 1, respectively. The first turbine 23 of the first turbocharger 9 is bypassed by a bypass passage 33 with a corresponding waste gate valve 34. The second turbine 1 of

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the second turbocharger 8 is equipped with a nozzle device according to the present invention, as it is shown in Figs. 1 to 4. Alternatively, the second turbine 1 may be provided with movable vanes which are capable to completely closing the annular nozzle. The movable vanes of this modification replace the fixed vanes according to the first embodiment, and similar effects as in the first embodiment are achieved by the nozzle device with movable vanes.

In the following, the operation of the parallel configuration of turbochargers will be described.

The parallel configuration of turbochargers according to Fig. 7 allows a highly efficient function of the internal combustion engine at low, medium and high rotational speeds of the internal combustion engine.

At a low rotational speed of the internal combustion engine, for instance at about 1000-2000 rpm, the tube-shaped piston 6 fully closes the annular nozzle 2 of the second turbocharger 8 as shown in Fig. 1. Advantageously, when the tube-shaped piston 6 closes the annular nozzle 2 of the second turbine 1 of the second turbocharger 8, the exhaust gas flow to the turbine 1 of the second turbocharger 8 is removed to avoid oil leakage from the bearing system thereof. The exhaust gas flow to the first turbine 23 of the first turbocharger 9 is reduced to ensure an idling rotation of the first turbocharger 9.

Under this condition, the speed of the first turbocharger 9 is controlled by means of the waste gate valve 34. At this stage, only the first turbocharger 9 works normally to supercharge the engine.

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At the low rotational speed, the butterfly valve 28 is open so that a re-circulation at the second compressor 25 is achieved. Due to the particular design of the configuration, during the re-circulation, the pressure in the second compressor 25 can be lowered so that the trust load becomes less important and the reliability is improved. The additional butterfly valve 30 remains closed and the first compressor 25 works normally to supercharge the engine.

In the range of a medium rotational speed of the internal combustion engine, for instance at about 2000-2500 rpm, the tube-shaped piston 6 opens progressively so as to regulate the pressure before the second turbine 1, as shown in Figs. 2 and 3, and the exhaust gas flow 18 drives the second turbine 1 of the second turbocharger 8. In the same time, the butterfly valve 28 is progressively closed in order to balance the power between the second compressor 25 and the second turbine 1, so that by operation of the butterfly valve 28, the speed of the second turbocharger 8 can be regulated.

In the range of a high rotational speed of the internal combustion engine, for instance at about 2500 - 4000 rpm, the tube-shaped piston 6 is completely or almost completely open, as shown in Fig. 4. The speed of the first turbine 23 is regulated by means of the waste gate valve 34. During this operation, the additional butterfly valve 30 is open and the butterfly valve 28 is totally closed to balance the power between the second compressor 25 and the second turbine 1.

Fig. 8 shows an application of the turbocharger 8 having a nozzle device according to the present invention in a diesel engine boosting system.

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The diesel engine boosting system basically comprises a single turbocharger 8 having a turbine 1 and a compressor 35 for a diesel engine 36. The turbine 1 includes a variable nozzle device according to the present invention. The air which is discharged from the compressor 35 is cooled by an intercooler 37 disposed between the compressor 35 and the engine 36. Thereby, the flow rate of the compressed air into the engine 36 is increased. At the intake side of the compressor 35, an air cleaner 38 for cleaning the intake air is disposed.

A diesel engine 36 generally requires for an engine braking operation, on the one side, a high back pressure upstream of the turbine 1 to achieve a high engine brake effect. The back pressure upstream of the turbine 1 increases as the opening of the nozzle device decreases.

On the other side, the pressure within a combustion cylinder of the engine 36 must be on a high level for maintaining the high back pressure upstream of the turbine 1. That is, for achieving a high pressure in the cylinder, the boost pressure downstream the compressor 35 must be high which in turn requires an operation of the compressor 35 to some extent. The compressor 35 increases the boost pressure as the opening of the nozzle device in the turbine 1 increases.

Consequently, the opening of the nozzle device must be optimised so as to achieve a large back pressure upstream the turbine 1 as well as a large boost pressure downstream the compressor 35. The optimisation of the nozzle opening is preferable performed by an electronically control device (not shown), for instance by means of a feedback-control of the back pressure upstream the turbine 1. The back pressure

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may be detected by means of a pressure detecting device (not shown) which is disposed upstream the turbine 1. The electronically control device variably feedback-controls the nozzle opening and must be free of any mechanical restrictions thereof. Thus, the variable nozzle device according to the present invention is advantageously suitable for this diesel engine boosting system because it is completely closeable so that there are no mechanical restrictions during the optimisation process.

Fig. 9 shows an application of the turbocharger 8 having a nozzle device according to the present invention in an engine boosting system.

The engine boosting system basically comprises a single turbocharger 8 having a turbine 1 and a compressor 35 for an engine 39, preferably for a gasoline engine 39.

The air which is discharged from the compressor 35 is cooled by an intercooler 37 disposed between the compressor 35 and the engine 39. Thereby, the flow rate of the compressed air into the engine 39 is increased. At the intake side of the compressor 35, an air cleaner 38 for cleaning the intake air is disposed.

The turbine 1 includes a variable nozzle device according to the present invention. At the outlet side of the turbine 1, a catalyst 40 for purifying the exhaust gas is disposed. The catalyst 40 exhibits its optimum purifying function only when the catalyst has reached a specific exhaust gas purifying temperature. Thus, at the start of the engine 39, the catalyst 40 must be heated up immediately. For doing so, the nozzle device of the turbine 1 is opened even at low rotational speeds at the start of the engine 39 such that the exhaust gas flow substantially bypasses the

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turbine wheel 13 of said turbine 1. The full open position of the nozzle device prevents heat losses at the turbine 1 for heating up the catalyst 40 very quickly.

Preferably, this method for heating up the catalyst 40 at the start of the engine 39 is suitable in a system comprising a turbocharger 8 having the nozzle device according to the present invention, where the nozzle device, which is completely closeable, must be forced to be open at the start of the engine 39.

Fig. 10 shows a nozzle device 12 of a turbine in a turbocharger according to a second embodiment of the present invention in an engine boosting system. The upper half shows the closed position, whereas the lower half shows the opened position.

The nozzle device according to the second embodiment comprises a variable annular nozzle 2 defined between an inboard wall 3 and a tube-shaped piston 106, wherein an annular arrangement of vanes 5 protrudes from said inboard wall 3.

The nozzle device according to the second embodiment structurally differs from the first embodiment in that said tube-shaped piston 106 comprises a stepped portion 117 which is axially slidable onto the radial outside of said annular arrangement of vanes 5 so as to contact said inboard wall 3.

The stepped portion 117 comprises a large inner diameter portion at the distal end of the tube-shaped piston 106 and a small inner diameter portion adjacent thereto. Thus, the stepped portion 117 has a geometrical shape for directing the exhaust gas entering into the turbine 1 more

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appropriately to the downstream side of the turbine wheel 13.

The thus shaped nozzle device is advantageously suitable in an engine boosting system according to Fig. 9 for quickly heating up the catalyst 40.

Although the invention is explained in detail with reference to the particular embodiment, the invention is not limited to the structures of the embodiment. In particular, instead of fixed vanes 5, movable vanes can be implemented. It is to be noted that the movable vanes may be operated separately or in combination with the tube-shaped piston 6, 106.

Claims

1. A nozzle device for a turbine of a turbocharger, comprising a variable annular nozzle (2) defined between an inboard wall (3) and an outboard wall (4), wherein said outboard wall (4) is axially movable for completely closing said variable annular nozzle (2).
2. The variable nozzle device according to claim 1, wherein an annular arrangement of vanes (5) is interposed in said variable annular nozzle (2), and said outboard wall (4) is constituted by a tube-shaped piston (6, 106) which is axially slidable into the radial inside or onto the radial outside of said annular arrangement of vanes (5) so as to contact said inboard wall (3).
3. The variable nozzle device according to claim 2, wherein said tube-shaped piston (106) comprises a stepped portion (117) which is axially slidable onto the radial outside of said annular arrangement of vanes (5), said stepped portion (117) directs exhaust gas entering into the turbine to the downstream side of the turbine.
4. The variable nozzle device according to any one of claims 1 to 3, wherein said annular arrangement of vanes (5) extends only over a part of the maximum interval between said inboard and outboard walls (3, 4).
5. The variable nozzle device according to any one of claims 1 to 4, wherein said inboard wall (3) is constituted by a vaned shroud (7) having said annular arrangement of vanes (5).

6. A turbocharger (8) having a turbine (1) comprising the variable nozzle device according to any one of claims 1 to 5.
7. An engine boosting system comprising a parallel configuration of at least a first and a second turbocharger (9, 8), wherein a turbine (1) of said second turbocharger (8) is characterized by a variable nozzle device which is capable of completely closing the nozzle opening thereof.
8. The engine boosting system comprising a parallel configuration of turbochargers according to claim 7, wherein the second turbocharger (8) is a turbocharger according to claim 6.
9. A method for operating an internal combustion engine with a parallel configuration of turbochargers (9, 8) according to claim 7 or 8, wherein the variable nozzle device of the second turbocharger (8) completely closes its nozzle opening when said second turbocharger (8) is driven under low rotational speed of the engine.
10. Diesel engine boosting system comprising a turbocharger according to claim 6 and control means for closing the turbine annular nozzle (2) to an optimum position for engine braking where there is provided a high boost pressure and a high back pressure at the same time.
11. An engine boosting system comprising a turbocharger (8) and a catalyst (40) disposed downstream of said turbocharger (8), wherein the turbocharger (8) comprises an exhaust gas driven turbine (1) having a turbine wheel (13) and an annular nozzle (2) which can be opened such that the exhaust gas flow substantially bypasses the turbine wheel (13).
12. The engine boosting system according to claim 11, comprising a turbocharger (8) according to claim 6.

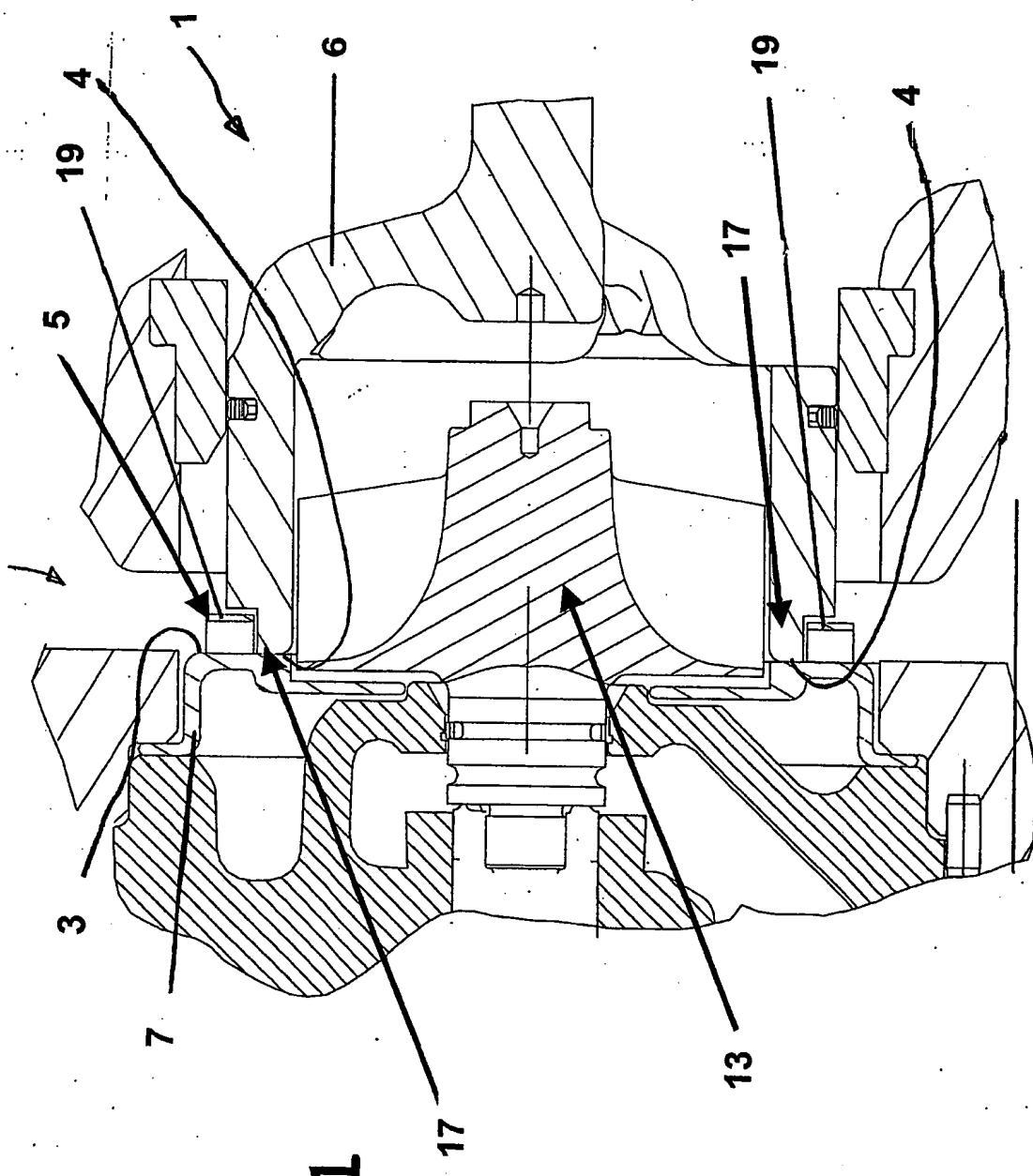


Fig. 1

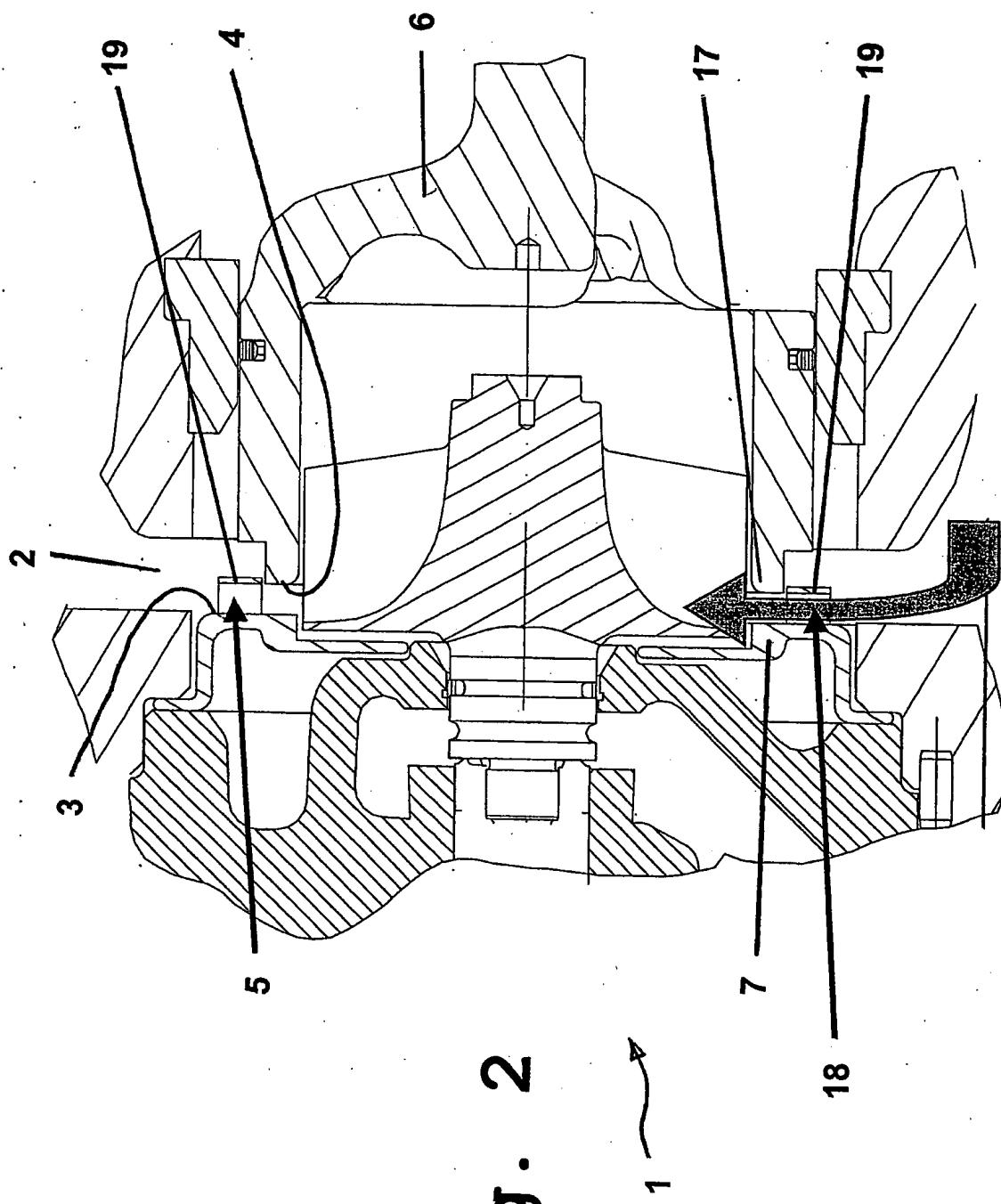


Fig. 2

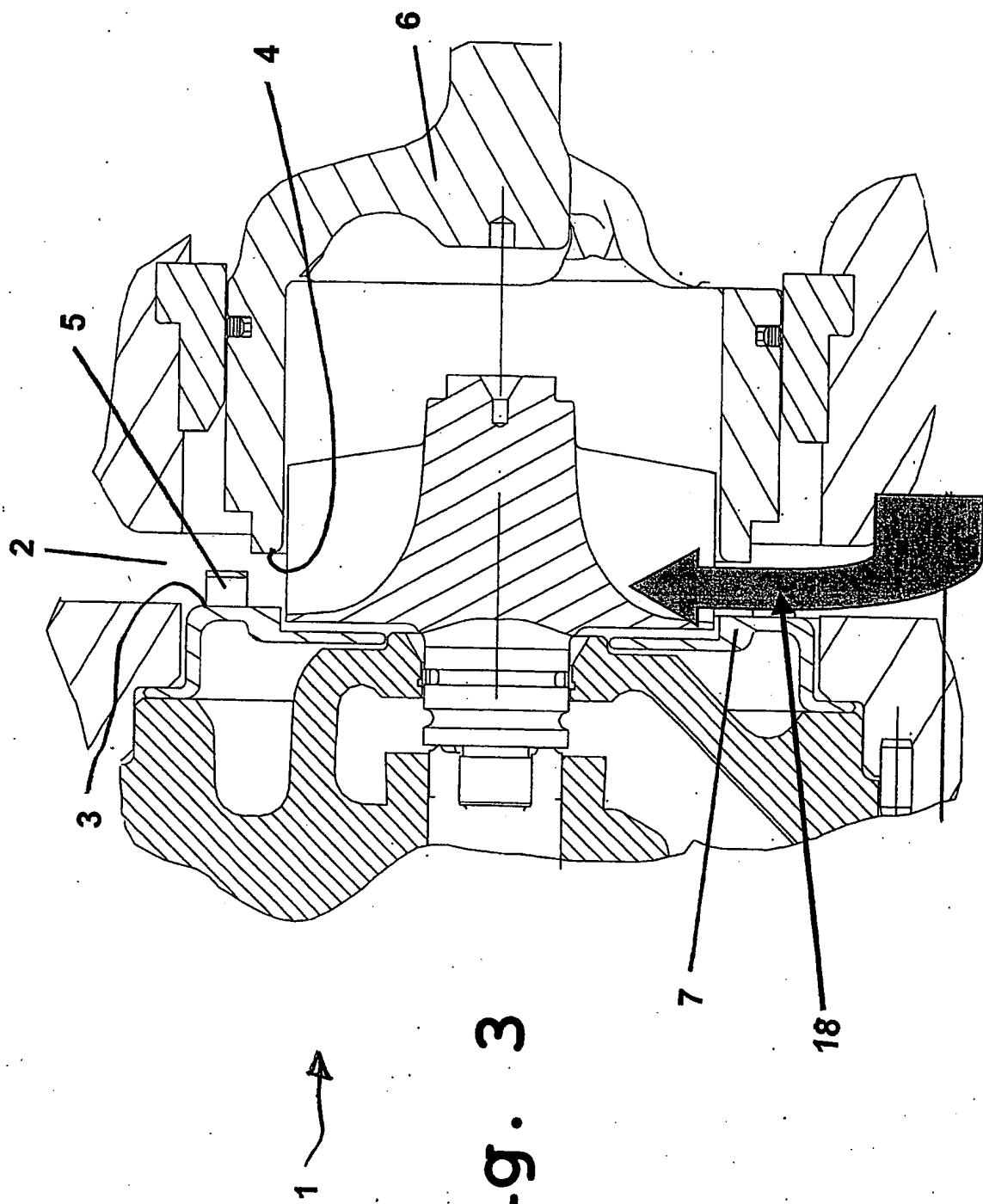


Fig. 3

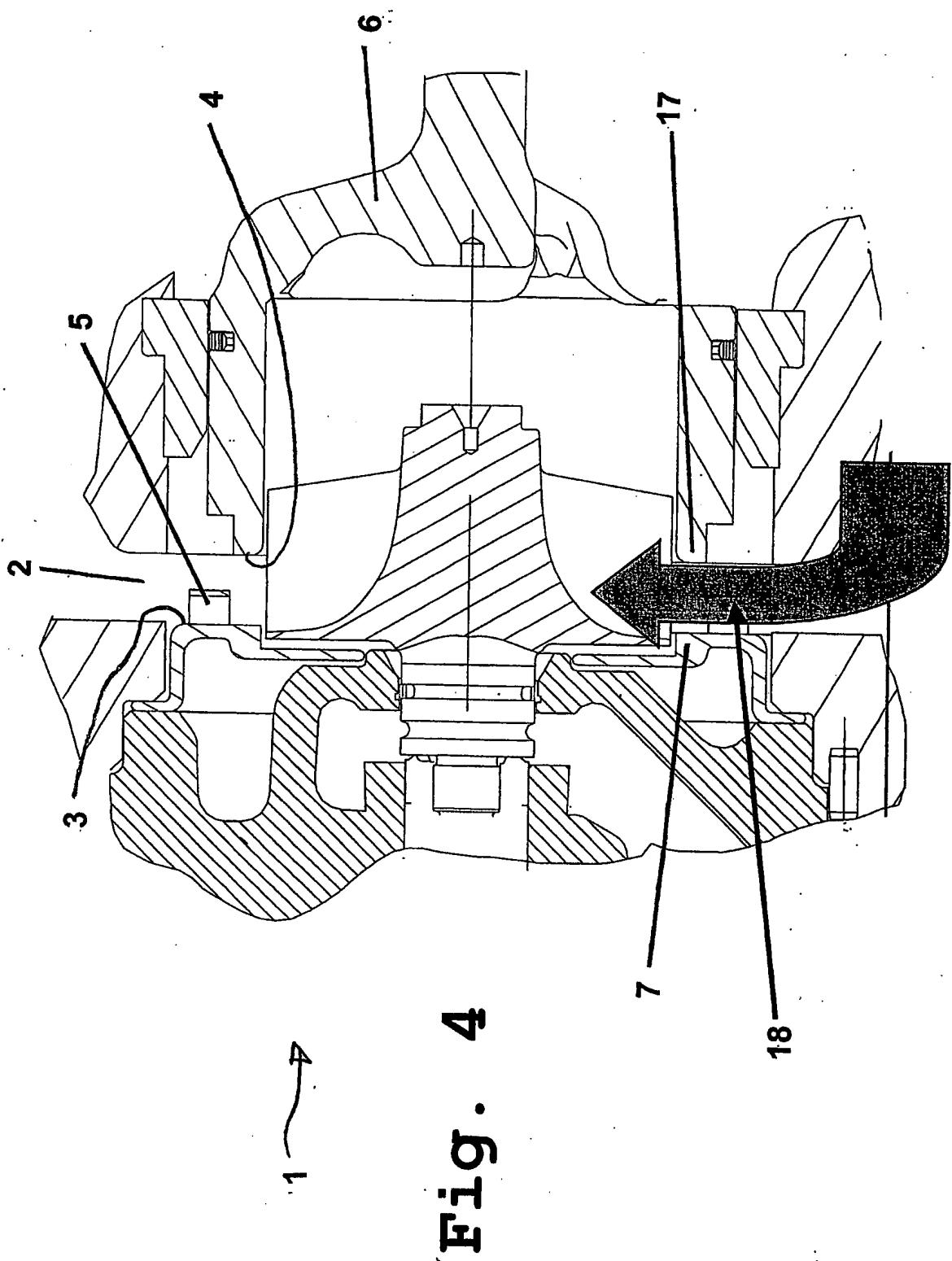
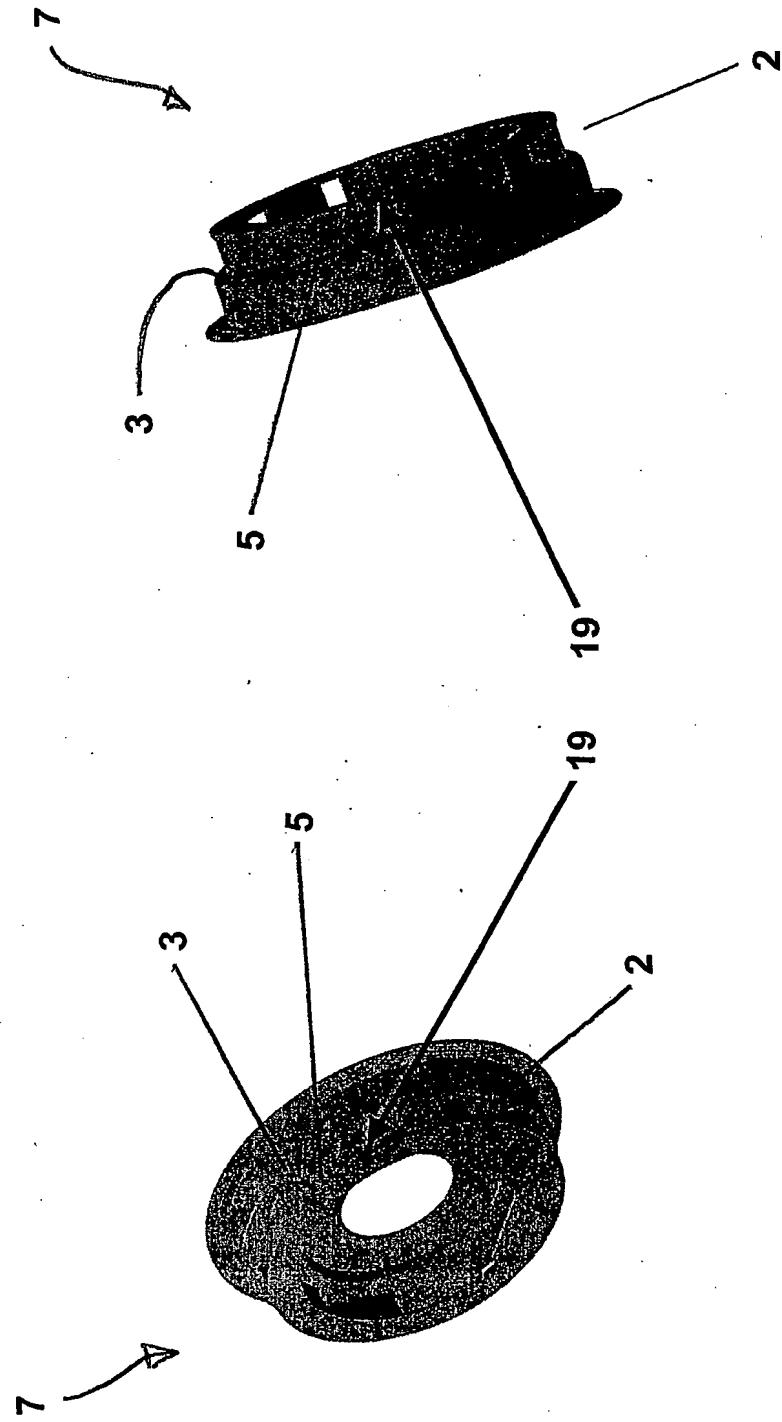


Fig. 5



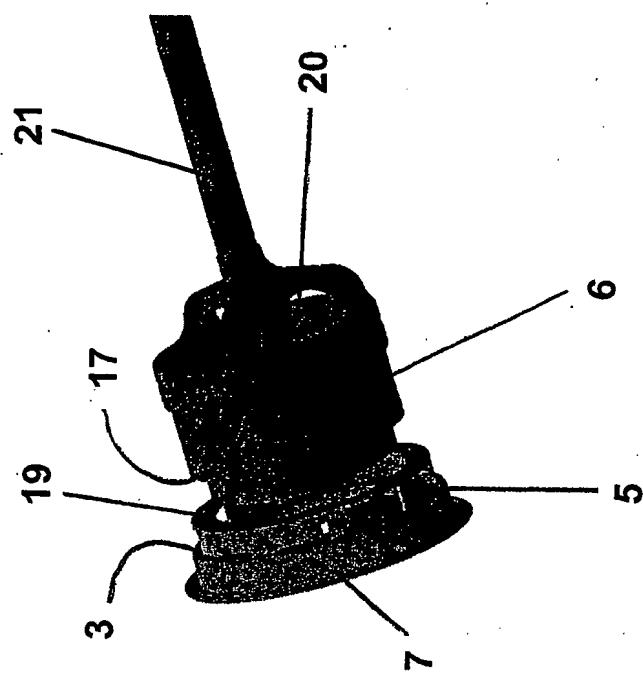
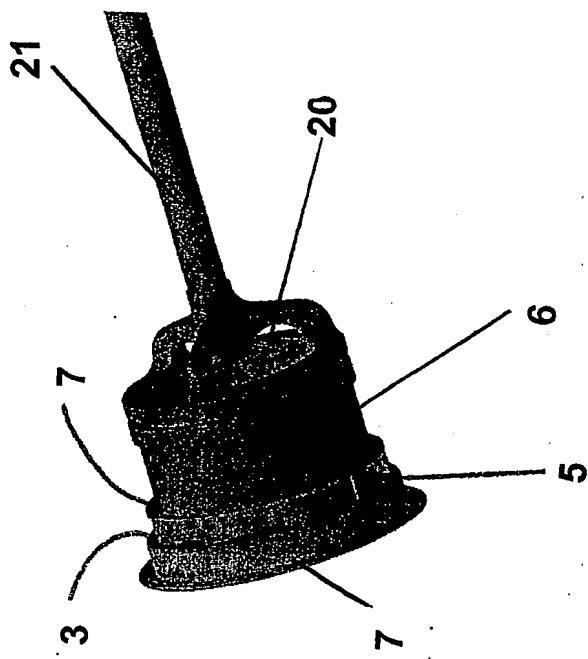


Fig. 6



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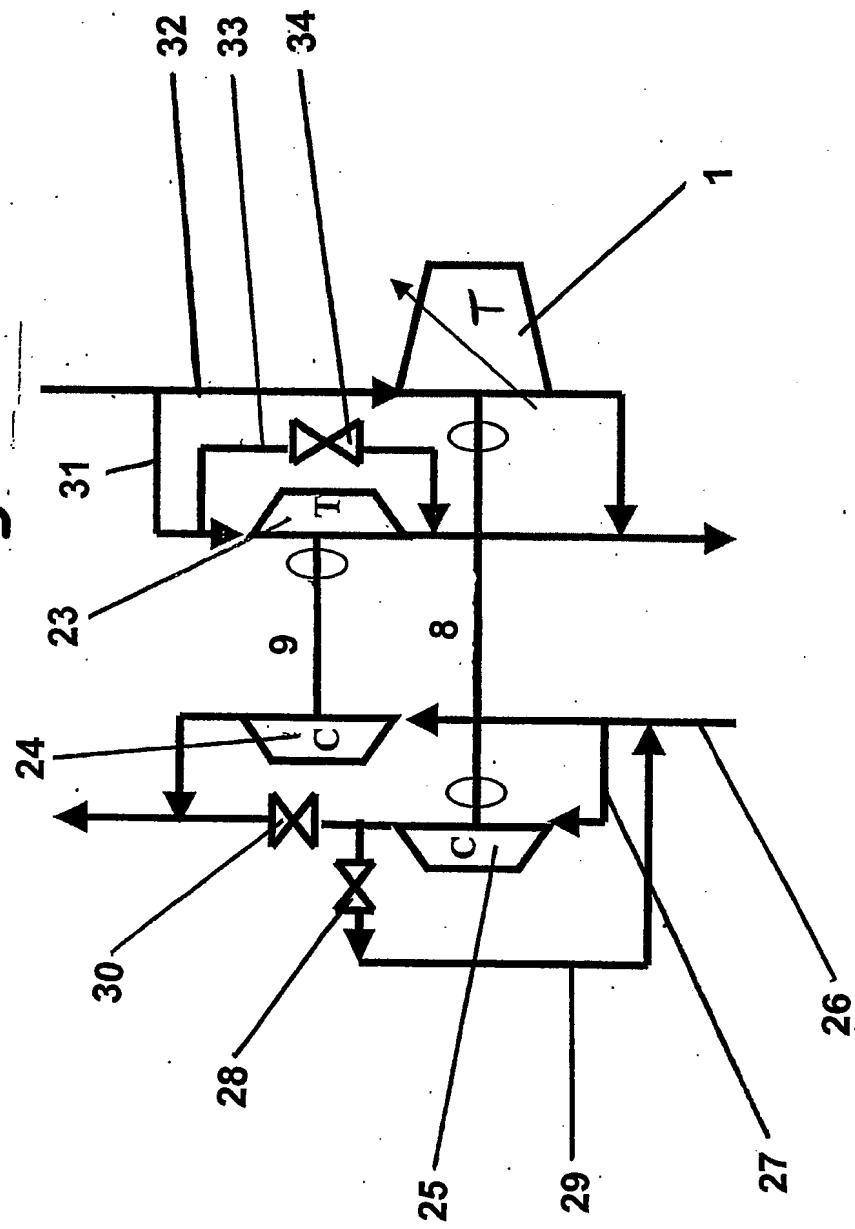


Fig. 8

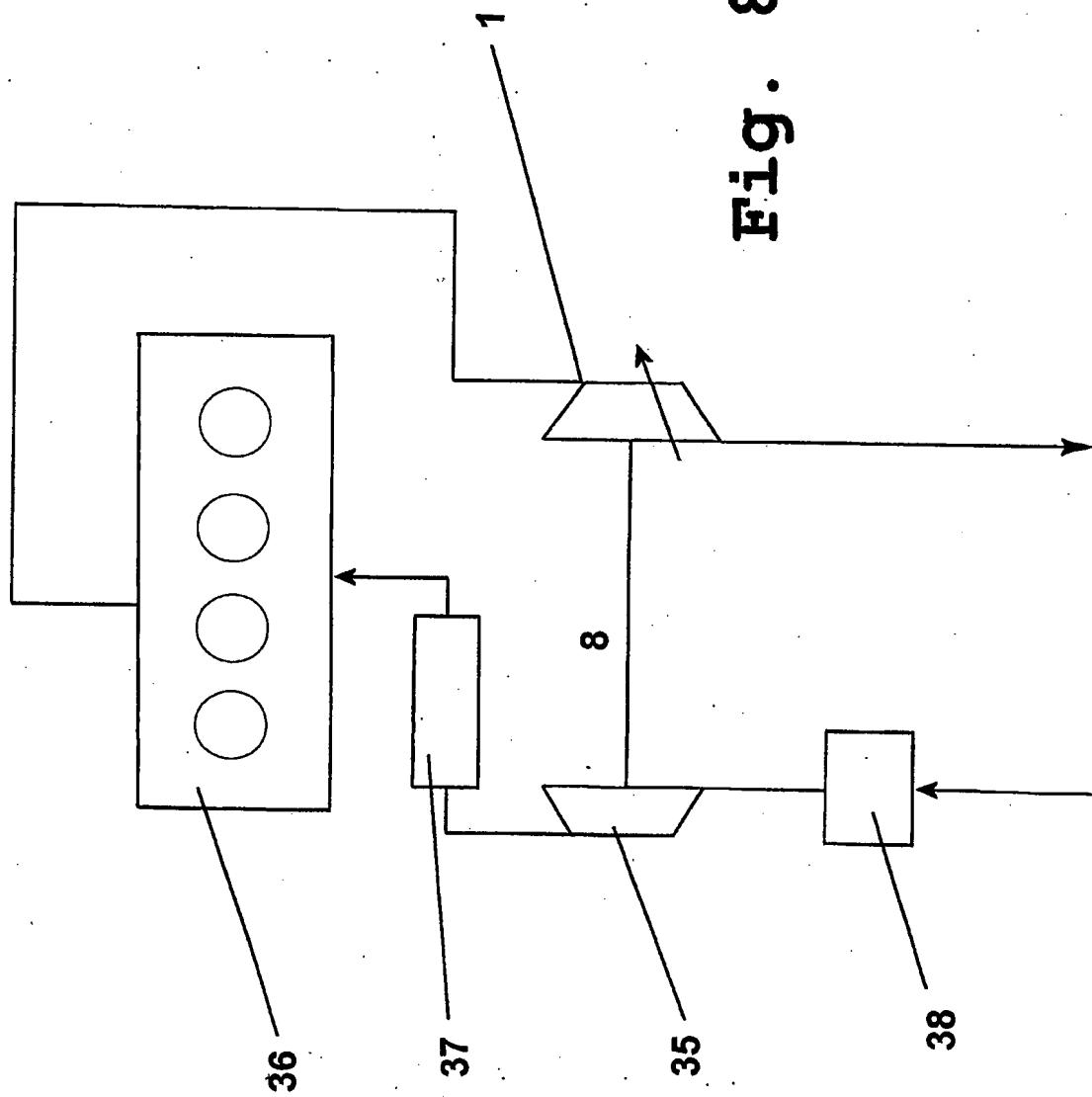


Fig. 9

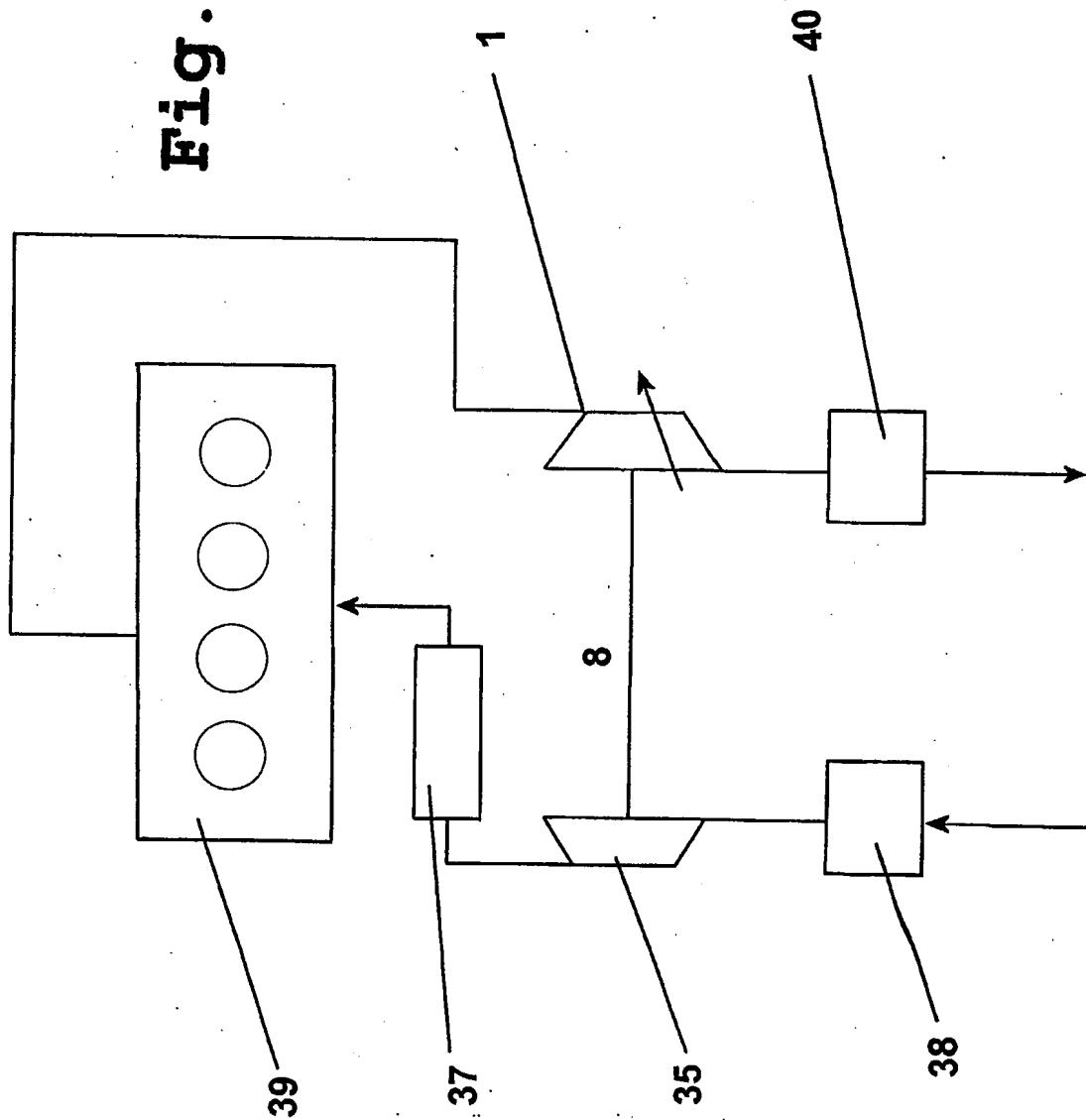
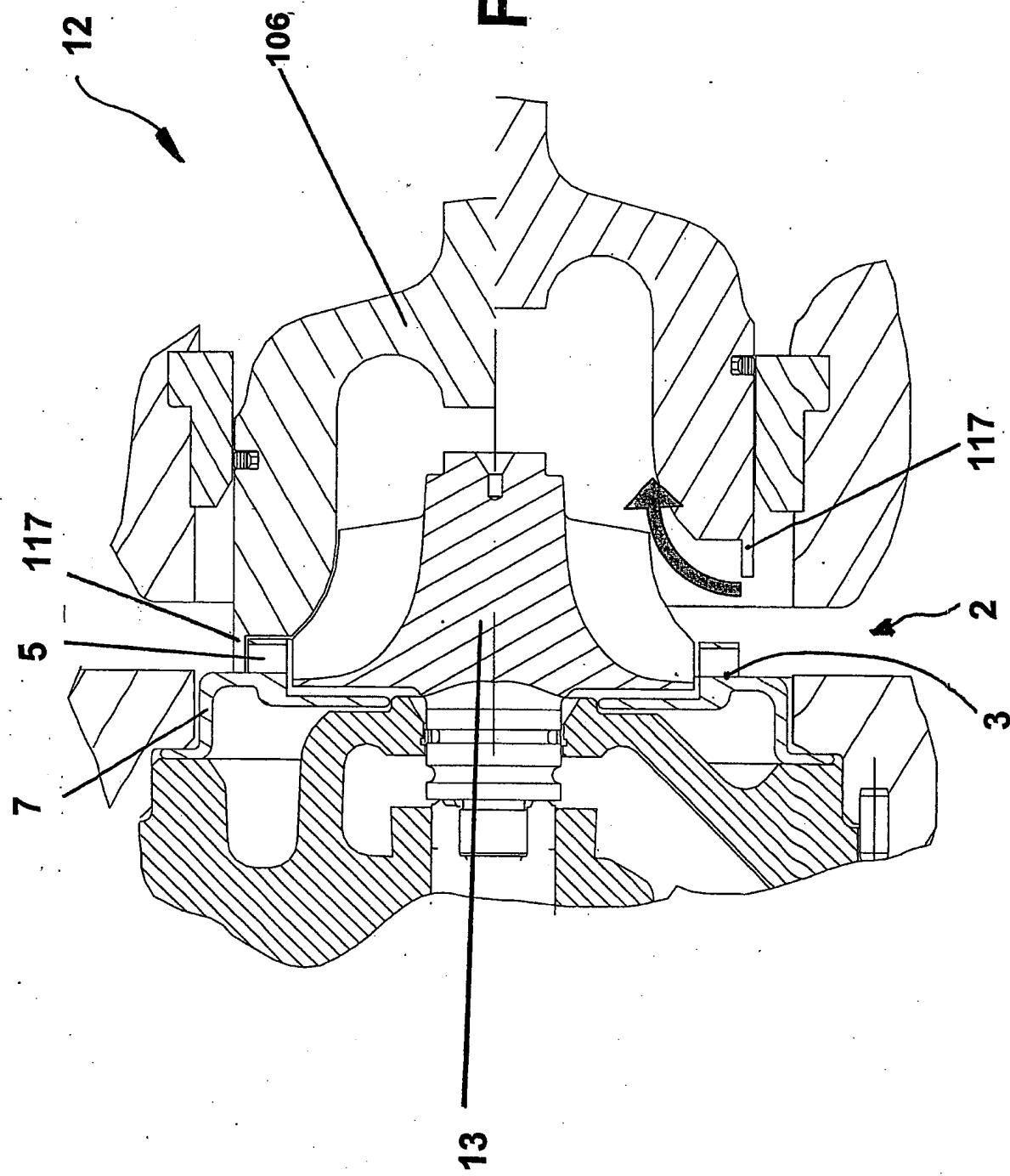


Fig.10



CLAIMS

1. Variable turbocharger apparatus comprising a housing, a compressor mounted for rotation in the housing, a turbine mounted for rotation in the housing, a first inlet for enabling air to be conducted to the compressor, an outlet for enabling air from the compressor to be conducted to an engine, a second inlet for enabling exhaust gases from the engine to be conducted to the turbine in order to rotate the turbine, a chamber which surrounds the turbine and which receives the exhaust gases from the second inlet before the exhaust gases are conducted to the turbine, and a bearing assembly for permitting the rotation of the turbine, the variable turbocharger apparatus comprising vanes which are mounted in the chamber and which are for accurately directing exhaust gases on to the turbine, a piston which is slidable and which is positioned between the housing and the turbine, and control means which is connected to the piston and which is for controlling the sliding movement of the piston, the piston having an end which is nearest the bearing assembly and which defines a gap, the size of the gap being variable in dependence upon the sliding of the piston under the control of the control means, the size of the gap being effective to control the amount of the exhaust gases that act on the turbine thereby accurately controlling the speed of rotation of the turbine and thereby the amount of air conducted by the compressor through the outlet to the engine, and the variable turbocharger apparatus having at least one bypass aperture which

is closed when the size of the gap is at a minimum and which opens when the gap reaches a predetermined size, the opening of the bypass aperture being such as to allow exhaust gases that are not required for acting on the turbine to bypass the turbine.

2. Variable turbocharger apparatus according to claim 1 in which the end of the piston is such that it has a flange which extends radially outwardly.
3. Variable turbocharger apparatus according to claim 2 in which the flange has slots for receiving the vanes.
4. Variable turbocharger apparatus according to claim 3 in which the slots are open slots which extend inwardly from the periphery of the flange, or closed slots in the flange.
5. Variable turbocharger apparatus according to any one of claims 2 – 4 in which the flange is such as to allow gases to bypass a back face of the flange whilst still allowing accurate gas flow onto the turbine.
6. Variable turbocharger apparatus according to any one of the preceding claims and including a heat shield for shielding the bearing assembly from heat from the exhaust gases.

7. Variable turbocharger apparatus according to claim 6 in which the heat shield is a ring-shaped heat shield.
8. Variable turbocharger apparatus according to claim 6 in which the heat shield is a disc-shaped heat shield having an outer ring portion, an inner wall portion, and an aperture through the inner wall portion.
9. Variable turbocharger apparatus according to any one of claims 6 - 8 in which the heat shield is a floating heat shield that is held in place under pressure by spring means.
10. Variable turbocharger apparatus according to any one of claims 6 - 9 in which the vanes are mounted on the heat shield.
11. Variable turbocharger apparatus according to any one of the preceding claims in which the bypass aperture is of a V-shape in order that gases are able to bypass in a controlled manner in order to prevent turbine surging.
12. Variable turbocharger apparatus according to any one of the preceding claims in which the bypass aperture is in an insert.

13. Variable turbocharger apparatus according to claim 12 in which there is a plurality of the bypass apertures.
14. Variable turbocharger apparatus according to claim 12 or claim 13 in which the vanes are mounted on the insert.
15. Variable turbocharger apparatus according to claim 14 in which the insert is a removable insert which is removable from the housing, the removable insert being such that it facilitates assembly of the variable turbocharger apparatus.
16. Variable turbocharger apparatus according to claim 15 in which the removable insert is a slidable insert.
17. Variable turbocharger apparatus according to claim 15 or claim 16 in which the insert is held in position by spring means.
18. Variable turbocharger apparatus according to claim 17 in which the spring is such that it forms a seal for preventing gas leakage from the chamber which surrounds the turbine.
19. Variable turbocharger apparatus according to claim 14 in which the insert is a non-removable insert which is not removable from the housing.

20. Variable turbocharger apparatus according to any one of claims 15 – 19 in which the piston passes through a bore in the insert.
21. Variable turbocharger apparatus according to any one of the preceding claims in which the piston has a first abutment for forming a seal against a mating surface thereby to prevent loss of the exhaust gases between the abutment and the mating surface.
22. Variable turbocharger apparatus according to claim 21 in which the mating surface is a mating surface on a part of the housing.
23. Variable turbocharger apparatus according to claims 9 and 21 in which the mating surface is a mating surface on the insert.
24. Variable turbocharger apparatus according to any one of claims 21 – 23 in which the piston has a second abutment for engaging against the end of the vanes, thereby setting the gap when the piston is in its closed position.
25. Variable turbocharger apparatus according to any one of claims 21 – 24 and including a sealing ring for forming an auxiliary seal for preventing

loss of any of the exhaust gases that pass between the first abutment and the mating surface.

26. Variable turbocharger apparatus according to any one of claims 1 – 20 and including a ring on the piston for setting the size of the gap at a start condition, the ring also being such that it acts as an abutment for preventing gas leakage.

27. Variable turbocharger apparatus according to any one of the preceding claims in which the control means includes a fork member, which is connected to the piston on two opposed sides.

28. Variable turbocharger apparatus according to any one of claims 1 - 25 which the control means includes a U-shaped member which is connected to a face of the piston.

29. Variable turbocharger apparatus according to any one of the preceding claims in which the control means is an electronic control means which operates as part of an engine management control system.

30. Variable turbocharger apparatus according to any one of the preceding claims in which the chamber is a volute.

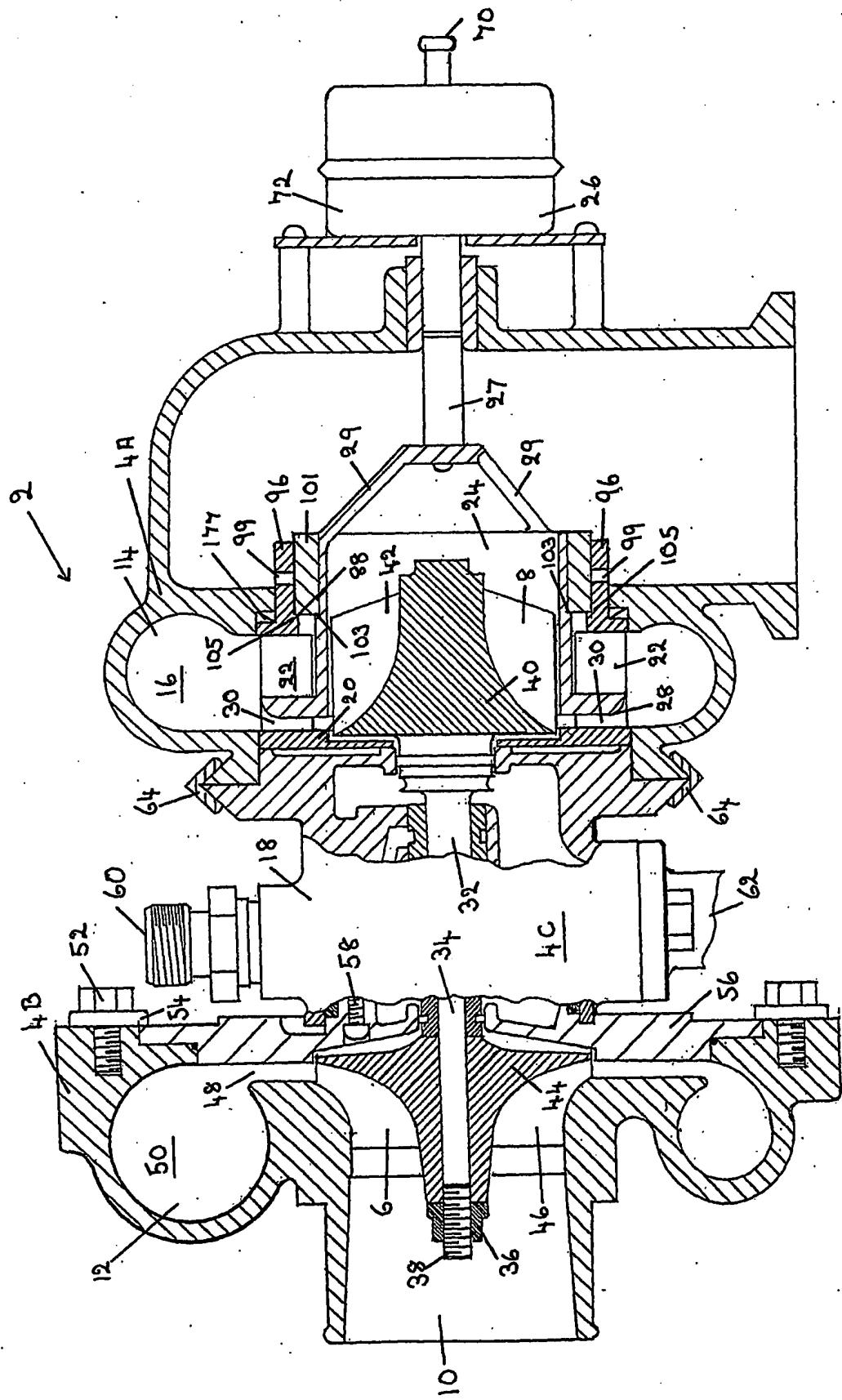


FIG 1

INTERNATIONAL SEARCH REPORT

Internal	Application No
PCT	03/04961

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 F01D17/10 F01D17/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 IPC 7 F02C F01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 855 117 A (SCHADE MARCO ET AL) 5 January 1999 (1999-01-05) abstract; figures	1,12,30
Y	column 2, line 10 - line 24 column 3, line 31 -column 4, line 34	2-8,10, 21-29
X	DE 199 24 228 A (3K WARNER TURBOSYSTEMS GMBH) 7 December 2000 (2000-12-07) abstract; figures	1,2,6,8, 21,22, 25,30
Y	EP 0 678 657 A (LEAVESLEY MALCOLM GEORGE) 25 October 1995 (1995-10-25) abstract; claims; figures 7-20	6,8,29
A	abstract; figures column 2, line 46 -column 3, line 35	30
		-/-

Further documents are listed in the continuation of box C.

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* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
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X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

& document member of the same patent family

Date of the actual completion of the international search

2 March 2004

Date of mailing of the international search report

08/03/2004

Name and mailing address of the ISA

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Fax (+31-70) 340-3016

Authorized officer

de Rooij, M

INTERNATIONAL SEARCH REPORT

Internat	Application No
PCT/GB	J3/04961

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	GB 2 271 814 A (LEAVESLEY MALCOLM GEORGE) 27 April 1994 (1994-04-27) abstract; figures 1-3 page 5, line 1 -page 8, line 19 ---	27
A	WO 03 023194 A (LEAVESLEY MALCOLM GEORGE) 20 March 2003 (2003-03-20) the whole document ---	6,8,30
P,Y	WO 02 44527 A (ESPASA OLIVIER ;HONEYWELL GARRETT SA (FR); LOMBARD ALAIN RENE (FR)) 6 June 2002 (2002-06-06) claims; figures 1-4 ---	2-5,7, 10, 21-26,28
A	EP 0 884 453 A (HOLSET ENGINEERING CO) 16 December 1998 (1998-12-16) the whole document ---	2,6,8, 10,21, 22,24, 25,30 1-30

Form PCT/ISA/210 (continuation of second sheet) (July 1982)

INTERNATIONAL SEARCH REPORT

 Interna Application No
 PCT/GB 03/04961

Patent document cited in search report		Publication date		Patent family member(s)	Publication date
US 5855117	A	05-01-1999	DE FR GB IT	19651498 C1 2756867 A1 2320294 A ,B RM970758 A1	16-04-1998 12-06-1998 17-06-1998 11-06-1998
DE 19924228	A	07-12-2000	DE EP JP WO	19924228 A1 1180198 A1 2003522310 T 0073630 A1	07-12-2000 20-02-2002 22-07-2003 07-12-2000
EP 0678657	A	25-10-1995	EP AT AT AU DE DE DE DE EP WO GB	0678657 A2 135440 T 173794 T 3693089 A 68925977 D1 68925977 T2 68928865 D1 68928865 T2 0442884 A1 8911583 A1 2236806 A ,B	25-10-1995 15-03-1996 15-12-1998 12-12-1989 18-04-1996 24-10-1996 07-01-1999 01-07-1999 28-08-1991 30-11-1989 17-04-1991
GB 2271814	A	27-04-1994		NONE	
WO 03023194	A	20-03-2003	WO	03023194 A1	20-03-2003
WO 0244527	A	06-06-2002	WO AU CA EP HU	0244527 A1 2181201 A 2423755 A1 1337739 A1 0302896 A2	06-06-2002 11-06-2002 06-06-2002 27-08-2003 29-12-2003
EP 0884453	A	16-12-1998	GB DE DE EP JP US US	2326198 A 69809130 D1 69809130 T2 0884453 A1 11072008 A 5868552 A 5941684 A	16-12-1998 12-12-2002 17-07-2003 16-12-1998 16-03-1999 09-02-1999 24-08-1999

INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 03/14013

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 F01D17/14 F02B37/007 F02B37/18 F02C6/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 IPC 7 F01D F02B F02C F04D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 342 889 A (HOLSET ENGINEERING CO) 23 November 1989 (1989-11-23) the whole document ---	1-4,6-10
X	EP 1 260 675 A (IVECO MOTORENFORSCHUNG AG) 27 November 2002 (2002-11-27) the whole document ---	1-10
X	GB 874 085 A (GARRETT CORP) 2 August 1961 (1961-08-02) the whole document ---	1-3,5-8
X	DE 10 34 192 B (BERNARD COLLIGNON;SNCF) 17 July 1958 (1958-07-17) figure 1 ---	1-3,5-10
		-/-

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
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- "O" document referring to an oral disclosure, use, exhibition or other means
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"&" document member of the same patent family

Date of the actual completion of the International search	Date of mailing of the International search report
12 July 2004	19/07/2004
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Koch, R

INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 03/14013

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 056 330 A (LIEBER JEAN) 1 November 1977 (1977-11-01) figure 1 ----	1,2,5-8
X	DE 102 10 369 A (DAIMLER CHRYSLER AG) 25 September 2003 (2003-09-25) the whole document ----	1,6-8,10
X	DE 199 24 228 A (3K WARNER TURBOSYSTEMS GMBH) 7 December 2000 (2000-12-07) the whole document ----	1,6-12
A		3
X	US 4 586 336 A (HOERLER HANSULRICH) 6 May 1986 (1986-05-06) figure 3 ----	1,2,5-9
X	US 6 158 956 A (ARNOLD STEVEN DON) 12 December 2000 (2000-12-12) the whole document ----	1,6-10
X	US 6 216 459 B1 (DAUDEL HELMUT ET AL) 17 April 2001 (2001-04-17) the whole document ----	1,6-8,10
X	DE 198 35 594 A (AUDI NSU AUTO UNION AG) 10 February 2000 (2000-02-10) the whole document ----	7,9
A		8,11,12
E	WO 2004/035994 A (HETTINGER RAPHAEL ;LOMBARD ALAIN (FR); LAVEZ ALEXIS (FR); SEVERIN) 29 April 2004 (2004-04-29) the whole document -----	1,4-12

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 03/14013

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP 0342889	A 23-11-1989	GB 2218744 A		22-11-1989
		BR 8902302 A		09-01-1990
		DE 68901360 D1		04-06-1992
		EP 0342889 A1		23-11-1989
		ES 2030973 T3		16-11-1992
		JP 2064203 A		05-03-1990
		JP 2730968 B2		25-03-1998
		MX 171870 B		22-11-1993
		US 4973223 A		27-11-1990
EP 1260675	A 27-11-2002	IT T020010506 A1		25-11-2002
		EP 1260675 A1		27-11-2002
		JP 2003035151 A		07-02-2003
		US 2003026692 A1		06-02-2003
GB 874085	A 02-08-1961	NONE		
DE 1034192	B 17-07-1958	NONE		
US 4056330	A 01-11-1977	CH 578686 A5		13-08-1976
		AU 8534775 A		07-04-1977
		BE 834102 A1		02-02-1976
		BR 7506332 A		10-08-1976
		CA 1037779 A1		05-09-1978
		CS 186719 B2		29-12-1978
		DE 2544055 A1		15-04-1976
		ES 441222 A1		16-03-1977
		FR 2286960 A1		30-04-1976
		GB 1516849 A		05-07-1978
		IT 1047331 B		10-09-1980
		JP 51062240 A		29-05-1976
		NO 753323 A		06-04-1976
		SE 418986 B		06-07-1981
		SE 7510981 A		05-04-1976
DE 10210369	A 25-09-2003	DE 10210369 A1		25-09-2003
DE 19924228	A 07-12-2000	DE 19924228 A1		07-12-2000
		EP 1180198 A1		20-02-2002
		JP 2003522310 T		22-07-2003
		WO 0073630 A1		07-12-2000
		US 6715288 B1		06-04-2004
US 4586336	A 06-05-1986	DE 3375419 D1		25-02-1988
		EP 0093462 A1		09-11-1983
		IN 159154 A1		04-04-1987
		JP 1813847 C		18-01-1994
		JP 5019013 B		15-03-1993
		JP 58192925 A		10-11-1983
US 6158956	A 12-12-2000	WO 0020726 A1		13-04-2000
		AU 1099100 A		26-04-2000
US 6216459	B1 17-04-2001	DE 19857234 A1		29-06-2000
		FR 2787142 A1		16-06-2000
		IT RM990742 A1		06-06-2001
DE 19835594	A 10-02-2000	DE 19835594 A1		10-02-2000

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 03/14013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2004035994 A	29-04-2004	WO 2004035994 A1	29-04-2004

DERWENT-ACC-NO: 2005-445254

DERWENT-WEEK: 200660

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TITLE: Nozzle device for turbine of turbocharger, has variable annular nozzle defined between inboard wall and outboard wall, wherein outboard wall is axially movable for completely closing variable annular nozzle

INVENTOR: FIGURA, G; PERRIN, J

PATENT-ASSIGNEE: HONEYWELL INT INC[HONE]

PRIORITY-DATA: 2003WO-EP14013 (December 10, 2003)

PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE	PAGES	MAIN-IPC
EP 1700005 A1	September 13, 2006	E	000	F01D 017/00
WO 2005059317 A1	June 30, 2005	E	032	F01D 017/14
AU 2003292223 A1	July 5, 2005	N/A	000	F01D 017/14

DESIGNATED-STATES: DE FR GB AE AG AL AM AT AU AZ BA BB BG BR BY BZ CA CH CN CO CR CU CZ DE DK DM DZ EC EE ES FI GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MA MD MG MK MN MW MX MZ NI NO NZ OM PG PH PL PT RO RU SC SD SE SG SK SL SY TJ TM TN TR TT TZ UA UG US UZ VC VN YU ZA ZM ZW AT BE BG BW CH CY CZ DE DK EA EE ES FI FR GB GH GM GR HU IE IT KE LS LU MC MW MZ NL OA PT RO SD SE SI SK SL SZ TR TZ UG ZM ZW

APPLICATION-DATA:

PUB-NO	APPL-DESCRIPTOR	APPL-NO	APPL-DATE
EP 1700005A1	N/A	2003EP-0767781	December 10, 2003
EP 1700005A1	N/A	2003WO-EP14013	December 10, 2003
EP 1700005A1	Based on	WO2005059317	N/A
WO2005059317A1	N/A	2003WO-EP14013	December 10, 2003
AU2003292223A1	N/A	2003AU-0292223	December 10, 2003
AU2003292223A1	N/A	2003WO-EP14013	December 10, 2003
AU2003292223A1	Based on	WO2005059317	N/A

INT-CL (IPC): F01D017/00, F01D017/14, F02B037/007, F02B037/18, F02C006/00, F02C006/12

ABSTRACTED-PUB-NO: WO2005059317A

BASIC-ABSTRACT:

NOVELTY - The nozzle device has a variable annular nozzle defined between an inboard wall (3) and an outboard wall (4). The outboard wall is axially movable for completely closing the variable annular nozzle.

DETAILED DESCRIPTION - INDEPENDENT CLAIMS are included for the following

- (A) a method for operating an internal combustion engine; and
- (B) a diesel engine boosting system

USE - For turbine of turbocharger used in internal combustion engine.

ADVANTAGE - Prevents heat loses at the turbine by full open position of nozzle device for heating up catalyst very quickly.

DESCRIPTION OF DRAWING(S) - The figure is the lateral section of a turbine having a nozzle device.

Inboard wall 3

Outboard wall 4

Fixed vanes 5

Tube-shaped piston 6

Vaned shroud 7

Turbine wheel 13

Stepped portion 17

CHOSEN-DRAWING: Dwg.1/11

TITLE-TERMS: NOZZLE DEVICE TURBINE TURBOCHARGE VARIABLE ANNULAR NOZZLE DEFINE

INBOARD WALL OUTBOARD WALL OUTBOARD WALL AXIS MOVE COMPLETE CLOSE

VARIABLE ANNULAR NOZZLE

DERWENT-CLASS: Q51 Q52

SECONDARY-ACC-NO:

Non-CPI Secondary Accession Numbers: N2005-361767